Hundred years of Polish chemical fibres (1911-2011). A reflection

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The history of Polish chemical fibres, which were initially called „artificial" or „man-made" fibres, started, like elsewhere in Europe, with cellulose fibres. And this article is mainly about the history of these fibres. During the past one hundred years these fibres have gone through a complete cycle, from rapid onset, through a period of maturity, then decline, and eventually demise. The story starts in 1911, when the Tomaszów Artificial Silk Factory was established [1].

The venture was a success, and shortly afterwards further such plants were built: in Myszków, Chodaków and Pabianice. The factory in Tomaszów Mazowiecki was not only the first, but for many years also the largest manufacturer of artificial fibres, and in the beginning it produced collodion fibres. Although it is assumed that the factory was opened on 1 May 1911, manufacturing reports indicate year 1912 as the first year. Production output during that year was nearly 56 tonnes of fibres. Output of the factory increased rapidly, reaching a maximum in 1928, when 733 tons of fibres were produced. The total production of collodion fibres, before its stoppage in December 1930, amounted to 4199 tons [2].

Feliks Wiślicki (18.05.1866-13.03.1945) in the 1930s

Today, after one hundred years, we are not aware of the many difficulties the inventors and manufacturers of collodion fibres had to overcome. There was a strong disinformation campaign designed to convince people that these fibres were something suspicious and dangerous for life, the campaign resembling the one launched earlier against the railway and the present one against genetically modified organisms [3]. There were also real problems. The most eminent were economic problems, such as the great amounts of ether and alcohol lost irretrievably to the atmosphere and the associated hazard to workers' health. There were also problems with the treatment of wastewater containing large amounts of sulphur compounds generated during the process of denitrating the fibres. We must therefore admire the courage of project developers and the determination of engineer Feliks Wiślicki, founder of the synthetic fibres industry in Poland.

In 1921 the Tomaszów factory began to manufacture, in addition to collodion silk, viscose rayon. The beginnings were modest: only a few hundred kilograms of rayon were manufactured during the first year of production. However, production was expanded rapidly, and in 1938 more than 4,100 tonnes of rayon were manufactured. In total 34 thousand tonnes of viscose rayon fibres were produced before the war. Another factory to achieve manufacturing success was one in Chodaków, established on 1 June 1926 and commissioned in December 1928. In 1929 it produced more than 300 tonnes of fibres and more than 1,100 tonnes four years later. This rapid construction and expansion rate, that is the route from design to final effect, is impressive, the more so when we bear in mind the pioneering nature of the venture, the modest technical means available and if we set it against the lengthy project development cycles of the 60s and 70s of the 20th century.

Feliks Wiślicki intended to build a similar factory in Myszków. A contract was signed on 14 November 1911. The factory, however, was not completed. Maybe it was only a twist of fate that Feliks Wiślicki engaged himself in Tomaszów, otherwise Myszków would be the first manufacturer of artificial fibres.

It was only after World War I, in 1925, when the management of the Belgian Fabrique de Soie Artificielle, where Feliks Wiślicki has been the manager for many years, showed interest in the factory. Majority of the shares were purchased by the Belgians, brothers Henri, Leon and Edmond Lagache; technical improvements were introduced, the plant's capacity was expanded from 200 to 400 t/a, and manufacture of viscose fibres was started. However, economic effects must have been very unsatisfactory, because in 1933 a motion for winding up the company was filed due to poor business. The motion was rejected by the general meeting of shareholders and the company continued operations, manufacturing ca. 300 tons per annum of viscose rayon with linear mass density of 80 to 300 den [4].

One other artificial fibres factory was to be built in the Free City of Danzig (Gdańsk). As the author and manager of the project, Benno Borzykowski, was a Pole, the factory may be treated as part of the history of the Polish industry. The factory named "Borvisk" Danzig-Polnisch Kunstseiden A.-G., owned by the American company "Borvisk", was to be built in the district of Oliwa, and a 20-hectares plot of land was even purchased for this purpose. The start-up, planned for September 1928, despite spending 12 million guldens and completing part of the manufacturing plant, never came to effect due to the economic crisis. The factory was also to manufacture artificial horsehair and viscose straw [5].

After World War II there were seven artificial fibre plants in Poland: in Tomaszów, Chodaków, Łódź, Wrocław, Jelenia Góra, Szczecin and Gorzów. Their history has already been described quite comprehensively [1,6]. Luckily there were people who were connected with these plants before and during the war, and who undertook to put them into operation again. The Myszków plant was so small that it was either forgotten or, perhaps, it was concluded that it was not worthwhile to undertake the venture. There was probably nothing left of the Gdańsk factory. Even the initial uncertainty as to the future of the so-called Regained Territories, has not prevented the resuscitation of the remainders of the plants found there. This was, by all means, a rational attitude. It was also encouraged by the new state authorities, which were implementing the new social order.

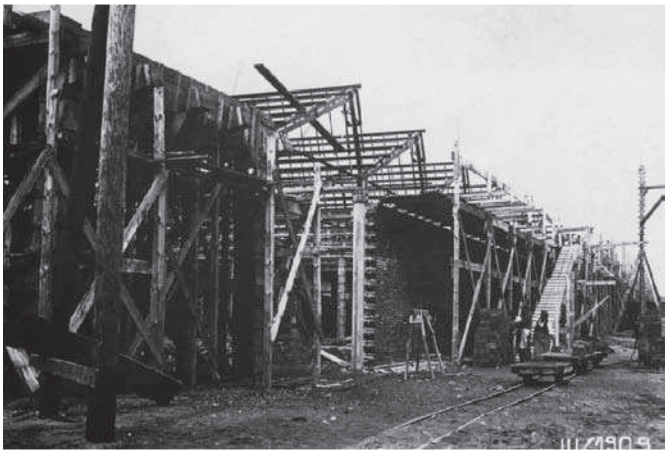
In early 1948 the deputy minister of industry and trade, Bolesław Rumiński, wrote: „our goal is not only to put in order and expand the production of soda, fertilizers, dyes, sulphuric acid, etc., but also to erect completely new, great factories, manufacturing plastics and artificial fibres, liquid fuels and synthetic rubber, pharmaceuticals, artificial leather and other consumer goods" [7].

From today's perspective it is obvious that the heralded development was a necessity every authority had to fulfil not only to ensure an acceptable standard of life, but also to industrialize the country and keep up with the more economically developed countries.

The German advanced synthetic fibres technology was encountered in Gorzów, on the Regained Territories. In that town, of the German name Landsberg, in an IG Farben plant, a distinguished German chemist, Paul Schlack, carried out his experiments. This was also the place where industrial scale manufacture of Perlon L was started. This fibre's Polish equivalent was "stilon", and according to present nomenclature it was Nylon 6. Such "surprises" could be expected, as the high level of German chemical industry was known and widely appreciated. An example of such repute is that of Bayer's aspirin. News were heard of an extraordinary American wonders of technology, e.g. nylon stockings. Synthetic fibres were therefore becoming a great public hope.

Synthetic fibres were not a complete novelty in Poland. However, they were not a product of common use before the war. The country, with 38.8 million inhabitants in 1938, produced 10,490 tons of synthetic fibres, which corresponds to 0.27 kg per capita [6]. The main textile raw materials, however, as elsewhere in the world, were cotton and wool, the consumption of which amounted to 2.1 and 0.9 kg per capita, respectively.

In 1938 the average consumption of fibres amounted to 3.7 kg per capita. Of that 0.4 kg was accredited to synthetic fibres, which corresponds to ca. 10.8% [8]. In this respect the situation in Poland before WWII could be described as rather satisfactory. The factory in Tomaszów manufactured then 4,112 tonnes of artificial silk and 3,160 tonnes of staple fibre, the factory in Chodaków manufactured 1,740 tonnes of artificial silk and 800 tonnes of staple fibre, the now forgotten factory in Myszków manufactured 280 tonnes of artificial silk, whereas an equally forgotten casein fibre plant „Polana" in Pabianice manufactured 400 tonnes of staple fibre.



Construction work at a building of one of the first fibre plants (March 1909)

The paper cited above also mentions another problem associated with the newly born viscose method of artificial silk manufacture and related to the use of carbon disulphide [3]. The concern was justified, but economic advantages were too big to prevent industrial application of the chemical.

The spectre of viscose factories being cut off from the supplies of this material contributed to the launching of its manufacture in Tomaszów in 1935 [9]. The application of the retort method of manufacture, the only one available at that time, had aggravated the health problems of workers of the Tomaszów factory and citizens of Tomaszów Mazowiecki. Despite these disadvantages, the factory, regularly modernized, operated until December 1972, when it was replaced by a new modern factory in Grzybów. Thus Tomaszów for nearly 45 years delivered carbon disulphide not only to Polish viscose and dye factories, but also to a factory in the city which was then called Breslau.

Experts of that time saw the need to expand both artifical fibres production as well as raw material facilities. The problem of carbon disulphide was solved in the first place. There was no special difficulty in providing soda lye and sulphuric acid from domestic sources; only the viscose cellulose had to be imported from abroad.

In 1934, in the new Central Industrial District, the construction of a cellulose plant was started in Niedomice. The plant also started the manufacture of viscose cellulose; in 1937 it produced 3000 tonnes of the product [10]. Another, much larger supplier, was to be a cellulose plant in Ławno near Grodno, the construction of which started in 1939. The reason for implementing this project was the anticipated increase of population of Poland, the need to reduce imports of cotton and wool, and also the global growth of viscose fibres production [10, 11]. The war had thwarted these plans.

After the war the situation on the global market began to change rapidly. The Western world quickly made up for the war losses and already in 1953 the average world consumption of fibres reached 4.1 kg that figure including 0.75 kg synthetic fibres. All fibres manufactured in chemical plants, both viscose fibres as well as polyamide fibres, were at that time called „artificial". Later on „synthetic" fibres were also distinguished. Initially polyamide fibres were the most popular synthetic fibres and then came polyacrylonitrile and polyester fibres, finally polyurethane fibres. Today these fibres are called either „chemical" fibres or „manmade" fibres.

The appearance of synthetic fibres and the remarkably fast growth rate of their production, many times faster than that of the first half of the 20th century, as shown in Table 1, began to have an effect on consumer habits, and consequently on proportions in consumption. It was predicted that in 1975 per capita consumption of fibres would reach 4.7 kg, of that 1.9 kg was accredited to synthetic fibres [8]. These predictions turned out to be accurate, despite the fact that world population was predicted to be 3.0 billion in 1975, while it actually reached 3.7 billion.

Table 1

Global production of natural and synthetic fibres, in thousands of tons

year	cotton	wool	cellu-lose	syn-thetic	total	population (billions)	kg/1 per capita
1890	2710	726			3436	1.57	2.19
1900	3162	730	1		3892	1.65	2.36
1910	4200	803	5		5008	1.70	2.95
1920	4629	816	15		5460	1.79	3.05
1930	5870	1002	208		7080	2.01	3.52
1940	6907	1134	1127	5	9173	2.24	4.09
1950	6647	1057	1611	70	9385	2.52	3.72
1960	10148	1466	2664	703	14981	3.03	4.94
1970	11784	1601	3585	4809	21780	3.69	5.90
1980	14137	1622	3522	10779	30060	4.43	6.78
1990	18200	1590	3189	16191	39170	5.26	7.45
2000	20750	1390	2600	28500	53240	6.07	8.77
2005	24398	1231	3138	38224	66991	6.45	10.39
2008	26100	1160	3339	38817	69416	6.75	10.29
2020*	32	1	3	81	117	7.54	15.52

Source:* Bywater N.: "Forecast Trends in the Global Production of Synthetic Fibers", International Fiber Journal, **2**, (2010), p. 4-8, millions of tons (according to: Chemical Fibers International 4, 18(1998); 2, 84(1999); 3, 8, (2000); 4, 202(2005) and International Fiber Journal 3,4(2009)

The history of discoveries in the area of synthetic fibres between end of 19th century and first half of 20th century indicates that these discoveries were made and developed in several countries at the same time in a relatively independent manner. Discoverers, mainly French, German, English and American, kept their secrets, and exchange of information was most often effected by means of scientific literature. Growing demand and increased export needs were met by erecting new manufacturing plants or lines [12].

The belief that this attitude will be maintained caused that in 1945, the Board of Synthetic Fibres Industry set up a research team, whose task was to develop a proprietary process of polyamide fibres manufacture. The team was based in the town of Jelenia Góra, where it worked and gathered experience on experimental and small scale production systems. This experience was useful during the construction of large industrial plants, particularly the nylon (Polish trade name „stilon") plant in Gorzów [13÷15]. Then we had a similar story with polyester fibres in late 50s, followed by polyurethane fibres during early 60s, although with much less success.

In mid 20th century the basic types of fibres, used both for garments as well as for technical purposes, were natural fibres. But already then it was noticed that the appearance of synthetic fibres has no impact on the volume of production of artificial fibres manufactured before, among which viscose fibres prevailed. At that time protein fibres were manufactured in addition to cellulose fibres.

In the mid 50s of the past century, in USA, the leader in both production as well as consumption of fibres, synthetic fibres constituted 20% of all fibres manufactured. According to the ambitious plans to catch up with the best, Poland was supposed to attain a fibres production growth rate close to that of the leaders [15]. Industrialization in Poland gave rise to increased demand for engineering fibres. Therefore in 1949 the plant in Tomaszów Mazowiecki started manufacture of viscose rayon cord. To this end two British-made "Nelson" spinning machines were purchased. These machines were the basis for designing a proprietary spinning machine: WP-2. Such machines were installed during the 50s and 60s in the plants in Szczecin and Tomaszów. Engineers in Szczecin had also developed a manufacturing process for Super 1 and Super 2 class cords. This process was successfully implemented at both plants. This shows that both the decision-makers of the Association of Artificial Fibres Industry, as well as the engineering staff at the individual plants made efforts to follow the routes of qualitative and quantitative progress by all possible means.

The plans for expanding manufacture of viscose fibres, mentioned before, were not just pompous slogans coined for propaganda purposes, but were the effect of analysing economic results. In the late 50s of the past century, statistics showed a 15÷18% average growth rate of fibre production in Poland, wherein artificial fibres, including viscose fibres, accounted for as much as 35% of the total volume of fibres. If we take into account the average global share of artificial fibres (22%), and the expectations of Polish consumers resulting from the aroused hopes, then the predictions were well grounded. At that time fibre consumption per capita in Poland was 7 kg, in Western Europe 8 to 12 kg, and in the United States it was over 17 kg [16].

Table 2

Plans for artificial fibre production growth in Poland in the years 1958-1965

Fibre type/years	1958*	1960	1965
Viscose rayon	18300	20600	31000
Viscose staple fibre	42200	47000	50000
Synthetic fibres	2270	4500	29000
Protein fibres	3450	3500	3500

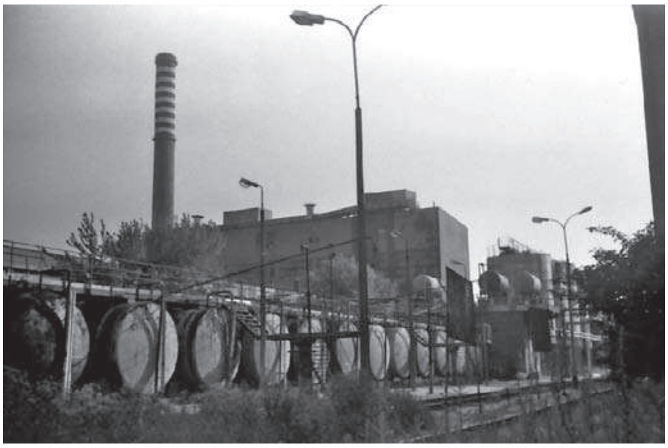
* actual production output

The author of the cited article, Marian Sobolewski, then the director of the Association of Artificial Fibres Industry, was well aware that fibre production could not be increased without expanding the raw materials base and the light industry, production of textile machinery, dyes and other raw materials. The plans for expanding this sector were therefore a part of the overall industry development plan.

At that time consideration was given to the feasibility of acetate fibres manufacture [17, 18]. The arguments for were the price of cellulose, lower by ca. 35% than that of the cellulose for viscose rayon, and availability of other raw materials, which were manufactured in Poland. Important was also the fact that 1 kg of cellulose makes 1.6 to 1.8 kg of acetate fibres, and only 0.9 kg of viscose fibres. Thus the amount of hard currency, required to purchase cellulose, would be nearly 3 times less than in the case of viscose rayon manufacture.

Moreover, acetate fibres have a 15% lower density, which improves their heat insulating properties. Garments made of these fibres better preserve the shape given to them, and in the 60s of the past century a fashion was set for non-iron textiles. The capital expenditures were expected to be lower than the cost of constructing a viscose rayon plant.

However, construction of an acetate fibre plant has never come to effect. The probable reasons were problems with solvent (acetone) regeneration and shortage of acetic acid. The technological level of solutions applied in the Soviet Union, which was to provide the manufacturing process know-how, and poor quality of fibres obtained in that process, helped make the decision [19]. Similar problems may have contributed to the rejection of considering the production of polyvinyl fibres, which have not met with favourable acceptance despite the launch of their manufacture, e.g. in Japan.



View of the sulphuric acid storage tanks (12 horizontal tanks, capacity 100 m^3 each, 2 head tanks on the building, further away vertical tanks for soda lye), Wiskoza 2 plant building and stack of the Central Ventilation Station No. 1 (1980)

Plans of 1960 for the next two decades called for the construction of 3 or 4 new viscose and synthetic fibre plants, and for the expansion of existing plants [20]. In 1980 the production volume of synthetic fibres in Poland was to reach 250 thousand tonnes, of that: 45 thousand tonnes of polyamide fibres (in Gorzów), 50 thousand tonnes of polyester fibres (in Toruń), 65 thousand tonnes of acrylic fibres (in Łódź). Additionally, Toruń was to produce 20 thousand tonnes of acetate fibres, polyvinyl alcohol fibres were to be manufactured in Łódź, and other fibre-forming polymers in a total quantity of 90 thousand tonnes were to be manufactured in new plants. Luckily, the plans for constructing plants for acetate and polyvinyl alcohol fibres manufacture were abandoned – in the long run these projects would not be profitable. Both these types of fibres, despite being manufactured in a few countries, have not found widespread use in the garments industry.

The production volume of viscose fibres was to reach 200 thousand tonnes that year, comprising mainly (125 thousand tonnes) cotton- and wool-like staple fibres, manufactured in Jelenia Góra, Tomaszów Mazowiecki and a new, large plant, under design since 1960, in Brzezie near Włocławek. Viscose rayon for textile manufacture purposes, in a total quantity of 30 thousand tonnes, was to be manufactured in Tomaszów Mazowiecki, Chodaków, Szczecin, Wrocław, and also in Brzezie, whereas cord rayon, in the same total quantity of 30 thousand tonnes, was to be manufactured in Tomaszów, Szczecin and Brzezie.

These changes in quantity would naturally change the structure of fibre consumption. Artificial fibres were to have the largest share: 55-

56%. Cotton would be the runner-up at 35-37%, while the proportion of wool would drop to 7-8%. The total consumption of fibres was to increase significantly to ca. 11 kg per capita, much above the world average.

It seems that when these bold economic plans were adopted, there must have been awareness of the many conditions that would have to be fulfilled for these goals to be achieved, as doubts began to emerge in the early 60s of the past century [21]. Stanisław Wydrzycki, who studied the fate of collodion and cuprammonium fibres manufacture, and changes taking place in the production structure in the United States, indicated the threats that viscose fibres could have been facing in the future. Among these threats was the rapid progress in the technology of polyamide and polyester engineering fibres. This progress, more distinct in the US than in Western Europe, would eventually have to become imminent in Poland and eliminate viscose fibres from engineering applications.

There was also a threat on the raw materials side. The major source of cellulose, until the 50s of the past century, was spruce wood. However, limited resources forced manufacturers to look for other sources of this feedstock. This quest included virtually every possible cellulose source, e.g. straw, but was eventually reduced to beechwood and pinewood. As a result, new grades of cellulose, obtained from more readily available wood, helped meet raw material demand and enabled manufacture of fibres of required quality. Although environmental movement was in its infancy and was neither an opinion-forming nor a political factor, there were some voices of condemn against wasteful exploitation of resources.

Economic threats were also becoming apparent. The growing number of cellulose and synthetic fibre plants must have led to changes in the cellulose and fibre markets. On the one hand there was a threat of raw material price increases, and on the other hand, the threat of slumping prices for finished fibres and of export problems. Export of Polish viscose fibres was not a very profitable business before the war [22], and now, with the strong competition from Western countries and under „cold war" conditions, it was much more difficult. Arguable attractiveness, high prices and lack of quality improvement of viscose fibres, despite the introduction of new types of fibres, such as polynosic fibres, led to a pessimistic conclusion that a downfall of these fibres was imminent.

Other important aspects of viscose fibres manufacture have been indicated by M. Zakrzewska-Rosner [23]. Her focus was primarily on the national economy's capacity to invest and on interrelations between the various sectors of industry. For her it was obvious that development of any of these sectors was not possible in isolation from the remaining sectors, as each such attempt would set off an „investment spiral", which the economy would not be able to endure and politicians would not be able to stop.

She wrote: „Although the rate of return calculated for each product is significant for the national economy, the most important issue is the maximization of the effects produced in the entire sector that meets a defined overall demand. In socialist countries market demand analysis and the need to fulfil that demand in a comprehensive and optimum manner should form basis for drawing up production plans. Thus, production volumes and assortments are defined at the programming stage, and the meeting of anticipated demand should reduce the elements of competitiveness of the various final products in the consumer goods market." However, experience has proved that satisfying these postulates was not possible by means of methods of central planning.

The planned increase of artificial fibres production was justified from the social point of view, but it was not economically feasible. The problem may have been solved by undertaking wider international cooperation between Comecon countries [24]. This postulate, despite establishing in 1964 an "Interchimvolokno" International Association based in Bucharest, has never been put into effect, and every Comecon state, virtually every plant, chose its own route, with regard to both machine design, as well as process development, following the worst traditions of the beginning of the century. Lack of coordination of efforts and market knowledge, poor productive abilities and other reasons prevented these countries from attaining any significant success in any of these areas.

In mid 1950s viscose plants began to shut down, initially only in the United States, due to low profitability of manufacture. In the 50s and early 60s of the past century, cellulose fibres seemed to be threatened mainly by polyamide fibres rather than polyester fibres, the latter eventually turning out to be winners. Viscose fibres were still able to compete in price. However, their prices remained unchanged for many years, while those of synthetic fibres were decreasing rapidly. Despite evident hygienic disadvantages, use of synthetic fibres in clothing applications was growing, while their supremacy in engineering applications was indisputable. There was therefore sound justification for intensifying research on synthetic fibres. Such research was undertaken, and significant theoretical achievements were made. An example of that was the work of Prof. A. Ziabicki. This, however, was not followed by practical success.

View of the sulphuric acid storage tanks (12 horizontal tanks, capacity 100 m^3 each, 2 head tanks on the building, further away vertical tanks for soda lye), Wiskoza 2 plant building and stack of the Central Ventilation Station No. 1 (1980)

Moreover, a growing point of concern was the shortage of domestic cellulose of appropriate quality for rayon manufacture. Cellulose from plants in Niedomice and Świecie was used for staple fibre manufacture, whereas for rayon manufacture only imported cellulose was used, mainly from Scandinavia. These imports called for substantial amounts of hard currency, which in turn required increasing exports, which often was not very profitable. Opinions about gloomy prospects for cellulose fibres were voiced again and suggestions on restricting capital expenditures in this area were made [27].

Other raw materials, that is soda lye, carbon disulphide and sulphuric acid, posed no problems; there were however significant financial problems with the so-called modifiers and assistants. These were special agents used in small amounts, manufactured mainly in Sweden and West Germany, particularly those for the manufacture of cords. They were very expensive and available only for hard currency. For instance, in 1988 the price of 1 tonne of cellulose was ca. 130,000 zlotys, soda lye – ca. 30,000, sulphuric acid – ca. 11,000, carbon disulphide – ca. 50,000, while that of modifiers often exceeded 1 million zlotys [2]. These price ratios were maintained until the end of viscose fibre production.

The cost of these materials accounted for 3-4% of the overall material costs, but the authorities pressed for substituting imported materials with domestic products. Small scale of the manufacture of these materials and lack of test methods to assess the properties thereof were an obstacle in developing production, as both the viscose fibre and modifier manufacturers were groping in the dark.

It is difficult to express an explicit opinion on the technological level of soda and sulphuric acid production, but the retort method of carbon disulphide manufacture, applied in Tomaszów Mazowiecki since 1935 till the end of 1979, was as obsolete as the fibre manufacture method itself.

Attention was also drawn to another aspect of cellulose fibre manufacture: its huge manpower requirements. The Polish cellulose fibres industry, which in late 60s of the past century provided 70% of all artificial fibres, employed 80% specialists, chemists and textile engineers of the entire sector [25]. These two figures, which described an industry with at least 50-years long history, along with the lack of any significant technological progress, indicated that the sector was facing serious problems.

Based on data given in [6], one can easily conclude that productivity, calculated as the amount of fibres manufactured in tonnes per 1 employee, was extremely low, and in 1980 it was equal to 2.1 t in Wrocław, 2.3 t in Sochaczew, 3.2 t in Szczecin and 3.8 t in Tomaszów. The somewhat better result of Tomaszów was due to high share of staple fibre in overall production, whereas the productivity at the viscose rayon line was the lowest at below 2 tonnes per employee.

Average productivity in the entire Chemitex Association was 8.2 t per employee. At the same time a viscose rayon plant in Rieti (Italy), with a capacity of 5,000 t of fibres, employed 204 people, and a Svenska Rayon staple fibre plant employed 106 people who produced 25,000 t of fibres; the Tomaszów plant had as much as 420 employees to produce 16,000 t of fibres!

The comparison of those two figures speaks for itself and indicates how obsolete our viscose fibres industry was. The most glaring exemplification of that was the „Wistom" viscose rayon plant in Tomaszów Mazowiecki, where, until its shutting down in 1997, rayon was manufactured on machines made in 1930! The quality of the fibres manufactured corresponded to the age of the machines. No wonder then, that the demand decreased rapidly, as the customers now had the freedom of choosing suppliers. As the result of slackening demand, viscose rayon production volume had to be reduced, which in turn caused the cost of production to exceed the price of product, leading eventually to bankruptcy of all of these plants.

In addition to technological problems, the sector faced growing environmental problems and incurred high expenses on employee health protection and environmental compliance [26]. This was a vicious circle that persisted until the end of existence of this industry. Lack of modern equipment, mainly in viscose fibre spinning mills, caused permanent excessive concentrations of carbon disulphide and hydrogen sulphide in air, both at the plant site and outside of it. Attempts were made to overcome this problem by installing increasingly large air treatment units. Their efficiency, however, was below expectations. High capital and operating costs of air and wastewater treatment facilities added to the decrease in economic efficiency of fibre manufacture. These investments fought symptoms, not the causes.

The first plants that were shut down were those that caused the worst nuisance to the surroundings. At the "Anilana" site in Łódź, the viscose fibres plant was shut down in 1980, followed by the protein fibres plant in 1984. The protein plant was a particular nuisance, and the reasons for its shutting down were of both economic as well as environmental nature. The next plant that was shut down was "Celwiskoza" in Jelenia Góra. Here the public pressure to close the plant was very strong.

These and other doubts, voiced also by people who had real effect on the operation of fibre manufacturing plants, turned out to be reasonable, which was shortly confirmed in real life. The production of cellulose fibres, which peaked in 1975, afterwards began to fall rapidly.

The last decade of the 20th century was the time of the final liquidation of the viscose industry. It started with the restructuring of the Wrocław plant, which shifted over to the manufacture of adhesive bandages. The former Chemitex site in Wrocław now houses a 3M Viscoplast SA plant, with only the name referring to the history of this place. In 1994 the Sochaczew plant declared bankruptcy, followed by Tomaszów in 1997. No attempts were made to restructure these companies, and their value at the time of shutting down was that of the scrap found at the sites.

Table 3

Cellulose fibres production output in Poland (in thousands of tonnes)

Year	Production output, (in thousands of tonnes)
1945	3.9
1949	22.1
1955	50.4
1960	69.9
1965	79.6
1970	80.6
1975	95.7
1980	86.4
1985	70.9
1990	35.6
1995	22.1
1998	3.7
1999	2.4
2000	~1

* Based on data from GUS Statistical Yearbooks

The Chodaków plant started to manufacture paper tubes in 1977, while at the Tomaszów plant preparations were made in the 1980s to start manufacture of superhard materials, but the scope of the project was very limited. In contrast to the Wrocław plant, where manufacture of obsolete products was completely abandoned and replaced with a different, modern product, these two plants were to continue manufacture of fibres.

The year 2000 was the last year of viscose fibre production in Poland: in May of that year the Wiskord plant in Szczecin was shut down. Also here, despite launching manufacture of polypropylene fibres, the manufacture of older assortment was maintained.

This is how the adventure of artificial cellulose fibres in Poland ended, and there is probably no chance of any revival. Only the synthetic fibres remained on the battlefield: polyamide, polyester and polypropylene fibres. Acrylic fibres (*Anilana*), manufactured since 1965, passed away in December 1996.

Abandoned factory buildings, in the foreground water pits where carbon disulphide storage tanks were once installed (these tanks were placed in water pits for safety reasons) (1999)

The shutting down of large fibre manufacturing plants, along with a number of spinning mills and garment manufacturing plants, has not deprived the nation of clothing, despite big concerns, as the "invisible arm of the market" filled in all the gaps. The availability of various fibres, textiles and fabrics, the number of garment manufacturers and the market level of their products outruns the boldest expectations of those who remember the 1960s, 70s and 80s. Thus it is worthwhile to ponder over the causes of the weaknesses of the economy of that time.

From today's perspective, it seems that the political, and probably the economic leaders in Comecon countries, failed to notice or ignored economic changes that were taking place in the world, and focused only on political changes. Politics were recognized as predominant over economy, but economic reality would in the end force even the most stubborn politicians into submission. However, one might say in their defence that these changes have also not been noticed in time by most managers in the West. In Europe viscose fibres have lost the market battle not only to synthetic fibres, but also to cotton, which had replaced viscose fibres in blends with polyesters used in clothing. Even Lyocell fibres, on which many hopes were placed, and which were to deal the final blow to viscose fibres, have not filled in the economic niche that was created. Perhaps the Chinese politicians and managers have foreseen the situation and have not only maintained the production of viscose fibres, but on the contrary, they are expanding it and now occupy an almost monopolistic position on this market. Fifteen years ago China produced ca. 400 thousand tonnes of viscose fibres, today the production volume approaches 2 million tonnes [24]. It also seems that there is a similarity between the Lyocell fibres case and PLLA fibres, which were also supposed to shake the polyester market.

In the global market some large suppliers of cotton, although it was ranked second on the list of fibres, but still remained an important fibre, were countries of the third world. As long as these nations were busy strengthening their statehood, they were willing to sell their resources to socialist countries, which in the past have supported their combat for independence and provided economic assistance. These nations adopted the principles of socialist economy. With time the economy in which exports of natural resource prevailed, was becoming less attractive as these countries had to struggle with burning demographic and social issues. One of the methods of mitigating economic difficulties was supporting the development of textile industry and construction of modern spinning and weaving mills. In the 1980s raw cotton became less available than yarn or textiles, which contributed to the shutting down of the Polish fibre industry, spinning and weaving.

The people responsible for the development of chemical fibres sector, have probably also missed, in addition to the growing number of fibre plants, spinning and weaving mills in countries providing natural fibres, cotton and wool, the changes taking place in the fibre and clothing market. Although technical and economic magazines brought news about the novelties, not much was done to study the market and to make appropriate preparations for the changing requirements that were inevitably going to emerge also in Poland. Many of these novelties were very short-lived. The manufacturers, however, even in case of failures, had gained priceless marketing knowledge. Novelties probed the market and its expectations and were a tool that was not available to a central planning institution, which was only able to emulate the actions of the surrounding world. Therefore there was always a time slip in the planners' actions.

An illustration of the delay in relation to market needs is for instance one of the arguments put forward for developing the production of acetate fibres [17]: „Launching production of acetate fibres creates grounds for developing other fibre types, including triacetate fibres, which **recently** conquer the market in the form of clothing and textiles that need no ironing, have permanent pleats, etc." This argument fails to take into account the impact of fashion and treats momentary trend as a permanent phenomenon. Such attitude, which was an opposition to innovation, led only to a pursuit of passing fashion and to late imitation.

The same may be said of the research that was conducted, the interface between science and industry. The minister of chemical industry of that time said: "We have mastered hundreds of processes, but no-one feels responsible for their development and further progress. Rapidly growing industry needs dozens of new sophisticated technologies. Research work alone, particularly in the area of applied studies, is of no practical value if it does not take on the shape of an industrial scale project that satisfies all criteria of economic efficiency." [28]. This statement just establishes the actual state, but it does not reveal the causes of such situation. And these causes could not be overcome in a command-and-quota economy devoid of market mechanisms.

Although the citation presented has a hint of optimism, in some areas a regression was noticed. The industry, oriented to large scale manufacture, which was easier to manage and account for, neglected or even held back the production of auxiliary agents, which were particularly important in the chemical fibres industry and were manufactured until the 1950s [29]. As a result of this, these agents had to be imported from abroad, which was not an easy task when there was shortage of hard currency.

A spool of viscose silk

Only occasional presence of Polish manufacturers on the global market prevented them from understanding the modern essence of fibre and clothing quality. Whereas Western manufacturers conducted comprehensive research: resistance to soiling, light fastness, shape stability, resistance to detergents, resistance to pilling, elimination of allergens from additives and many other – all of this was subject to research and market trials. Much less stress, at least in relation to textile fibres, was laid on physical and chemical properties, e.g. strength.

The Polish chemical fibres industry since the 1960s had no ability to introduce new types of fibres because it had no reasonable market offers, and purchasing licences for existing products would be pointless due to obsolescence of technological assets. The only feasible solution was to construct a completely new plant. This, to some extent, has been accomplished by constructing in the 1970s a polynosic fibres plant in Tomaszów. Taking out any licences could not be taken into account because of the national debt and political problems.

Therefore in 1994 it was easy to formulate categorical theses about the inability and lack of justification for maintaining the production structure of the 1980s [30]. Although this article is about „domestic industry", but as there were only two operating plants in Poland, and Wistom in Tomaszów was the larger, conclusions could be extrapolated to the whole of the country. And these conclusions were pessimistic: „1) All products manufactured are obsolete and require modernisation. 2) Engineering personnel is not able to develop new product manufacturing processes on their own. 3) The company can expand only after acquiring substantial financial and technical assistance."

Fulfilling condition number three, which would annul the previous two conditions, could in practice be achieved only by selling the plant to a Western company. But all this was only wishful thinking with no hopes for succeeding: no-one in the European Union, except for Austria, cared for viscose fibres. Thus, the effect could only be one.

In the 50s and 60s of the past century the Polish chemical industry aspired to the title of a national industry. This term, also used in other countries with regard to major industrial sectors, had then a propaganda and emotional significance. However, the world industry, its globalization, made the term useless. The world has transformed into a "global village" with no place for "national" industries and no possibility of reviving such ideas. Attempts to do this would be aimless and would form an obstacle for social and economic development. The history of the Polish chemical fibres industry is a proof of that.

Photographs are from the collection of Mr Józef Gołębiewski.

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The International Year of Chemistry 2011 (IYC 2011) is a worldwide celebration of the achievements of chemistry and its contributions to the well-being of humankind. Under the unifying theme "*Chemistry—our life, our future*," IYC 2011 will offer a range of interactive, entertaining, and educational activities for all ages. The Year of Chemistry is intended to reach across the globe, with opportunities for public participation at the local, regional, and national level.

The goals of IYC2011 are to increase the public appreciation of chemistry in meeting world needs, to encourage interest in chemistry among young people, and to generate enthusiasm for the creative future of chemistry. The year 2011 will coincide with the 100th anniversary of the Nobel Prize awarded to Madame Marie Curie—an opportunity to celebrate the contributions of women to science. The year will also be the 100th anniversary of the founding of the International Association of Chemical Societies, providing a chance to highlight the benefits of international scientific collaboration.

IYC 2011 events will emphasize that chemistry is a creative science essential for sustainability and improvements to our way of life. Activities, such as lectures, exhibits, and hands-on experiments, will explore how chemical research is critical for solving our most vexing global problems involving food, water, health, energy, transportation, and more.

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- **Chemistry – the key to Africa's future South African Chemical Institute Convention** - Jan 16 - Jan 21, 2011 - Johannesburg, South Africa
- **Official IYC Launching Ceremony IYC 2011 - International Launching Ceremony -** Jan 27 - Jan 28, 2011 - UNESCO HQ, Paris, France
- **PAC Symposium PAC Symposium 2011** - Mar 03, 2011 - Utrecht, Netherlands
- **Pittcon 2011** - Mar 13 - Mar 18, 2011 - Georgia World Congress Center, Atlanta, Georgia
- **Marie Curie and Aspects of the History of Radiochemistry** - Mar 18, 2011 - Piccadilly, London, UK
- **International Congress of Industrial Chemistry 2011** - Apr 05 - Apr 08, 2011 - Universidad Autónoma de Nuevo León, Monterrey, México
- **75th Prague Meeting on Macromolecules Conducting Polymers -** Jun 10 - Jun 14, 2011 - Prague, Czech Republic
- **Chemspec Europe 2011 Chemspec Events - the fine and specialty chemicals connection -** Jun 15 - Jun 16, 2011 - Hall 1, PALEXPO, Geneva, Switzerland
- **Brussels closing event IYC Closing Event -** Dec 01, 2011 - Brussels, Belgium